

FRAM: Advanced Feature Set Pulls the Technology Into the High Density Domain

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Ferroelectric integrated circuit memory, FRAM, has been in production for ten years, advancing up the VLSI density path towards ULSI. Areas in the technology's development that have been critical in the past and will be critical in the future are discussed in this paper. These are, in the order in which they have been solved: design techniques; materials of construction; tools for fabrication; standard CMOS process compatibility, feature set definition; reliability; industry acceptance and standardization; and finally, FRAM competitiveness in the market place. Designs have advanced from early 6T2C cells to 1T1C commercial offerings at present. The path to high purity and high performance ferroelectric materials is established. Industry standard tool sets are available and can be understood in standard semiconductor terms such as cost of ownership and vendor support. Ease of integration into a conventional CMOS flow is outlined. The feature set initially focused on NVM retention attributes, but now includes other high-performance NVM qualities such as fast write, high endurance, low power, ease of integration, and perhaps most importantly in comparison to other competing technologies, high reliability. Acceptance and standardization as cast in the ITRS is critiqued. Finally the economic marketplace for FRAM is examined and a forecast made for key market drivers to understand how large the economic impact will be this decade.